

Factor Structure and Reliability of the Arabic Version of the Learning and Study Strategies Inventory: Second Edition (LASSI-II)

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Although there is a robust body of research that has addressed the psychometric properties of the Learning and Study Strategies Inventory (LASSI) in different populations, no study has yet investigated the factor structure and congeneric reliability of the Arabic version of the Learning and Study Strategies Inventory, 2nd edition (LASSI-II) among Egyptian undergraduates. This study examined the test factor structure, the underlying factor structure of the subscales, and the congeneric reliability (omega coefficient) of an adapted Arabic version of the LASSI-II. Participants were 303 Egyptian undergraduate students. Results of confirmatory factor analyses revealed that each subscale had satisfactory goodness-of-fit indices. Results also confirmed the three-factor model (ER-GO-CA) proposed by Olejnik and Nist (1992) and refined by Olaussen and Braten (1998). Finally, results indicated relatively high omega coefficients for the subscales ranging from a low of .65 (Study Aids) to a high of .86 (Self-testing). Implications and suggestions for future research are presented.

Effective learning and study strategies help undergraduate students achieve better learning outcomes. Three decades ago, Weinstein, Zimmermann, and Palmer (1988) highlighted the need to assess learning strategies for students prior to enrolling in academic programs to identify likely deficits in their learning profiles. Entwistle and McCune (2004) noted,

There has recently been a great interest in describing and measuring the study strategies of students in higher education. This development is due to the increasing requirements on universities to justify public funding by demonstrating effectiveness and efficiency in their teaching (p. 325).

Measuring such strategies using standardized instruments helps educators know more about the strategies utilized by students in different educational contexts and helps them achieve better learning outcomes. It is accordingly very important that valid and reliable instruments should be used to measure learning and study strategies of undergraduate students in different populations.

Weinstein and Palmer (1987) developed the first version of the Learning and Study Strategies Inventory (LASSI-I) for undergraduate students as part of the cognitive learning project at the University of Austin, Texas. Weinstein and Palmer (1990) developed a version for high school students and called it (LASSI-HS). Since that time, it has become one of the most widespread instruments for measuring learning and study strategies. In 2002, they updated the first version of the LASSI-I for undergraduates and developed the second edition (LASSI-II).

The first and high school versions had 77 items. The second edition has 80 items. The additional three items were related to using recent technological resources in

the study aids subscale. The difference between the LASSI-I and the LASSI-II does not lie only in the addition of three items, but also in the wording of other items as well. Accordingly, the LASSI has three versions, namely the LASSI-I (1st ed.) published in 1987; the high school version, LASSI-HS, published in 1988; and the LASSI-II (2nd ed.) published in 2002.

The LASSI-II assesses three components of strategic learning: skill, will, and self-regulation. This model is later known as the S-W-SR model of the learning and study strategies or the original model. The skill component of strategic learning has three subscales. The information processing subscale assesses how well students can use imagery, verbal elaboration, organization strategies, and reasoning skills as learning strategies to help them learn new information and skills and build bridges between what they already know and what they are trying to learn and remember (e.g., “Do students try to summarize or paraphrase their class reading assignments?”). The selecting main ideas subscale assesses student skill at identifying important information for further study (e.g., “Can students identify the key points in a lecture?”). The test strategies subscale assesses student use of both test preparation and test taking strategies (e.g., “Do students know how to study for tests in different types of courses?”).

The will component of strategic learning has also three subscales. The anxiety subscale assesses the degree to which students worry about school and their academic performance (e.g., “Are students easily discouraged by low grades?”). The attitude subscale assesses student attitudes and interests in college and achieving academic success (e.g., “How clear are students about their own educational goals?”). The motivation subscale assesses student diligence, self-discipline, and willingness to exert the effort necessary to complete academic requirements successfully (e.g., “Do students stay up-to-date in class assignments?”).

The self-regulation component of strategic learning has four subscales. The concentration subscale assesses student ability to direct and maintain attention on academic tasks (e.g., “Are students easily distracted?”). The self-testing subscale assesses student use of reviewing and comprehension monitoring techniques to determine level of information understanding or task to be learned (e.g., “Do the students review before a test?”). The study aids subscale assesses student use of support techniques, materials or resources to help them learn and remember new information (e.g., “Do students complete practice exercises?”). The time management subscale assesses student use of time management principles for academic tasks (e.g., “Are students well organized?”).

The LASSI-II is used in different educational settings. It may be used as follows:

- 1) A screening measure to help students develop greater awareness of their learning and studying strengths and weaknesses,
- 2) A diagnostic measure to help identify areas in which students could benefit most from educational interventions,
- 3) A basis for planning individual prescriptions for both remediation and enrichment,
- 4) A means for instructors to use for examining individual students' scores and class trends to help them decide where to place the greatest emphasis for assignments, projects, individual logs, journals, portfolios and other class activities,
- 5) A pre-post achievement measure for students participating in programs or courses focusing on learning strategies and study skills,
- 6) An evaluation tool to assess the degree of success of intervention courses or programs and
- 7) An advising/counseling tool for college orientation programs, advisors, developmental education programs, learning assistance programs, and learning center (Weinstein & Palmer, 2002, p. 4).

Based on its various uses, Flowers (2003) reported, “[M]ore than 1,700 colleges and universities have used the LASSI to assess the extent to which students make use of study skills to learn new information in college” (p. 32). This is an indication of the widespread use of the LASSI for assessing student learning and study strategies. However, Olaussen and Braten (1998) explained that researchers should focus not only on the theoretical bases of the tool, but also on its applicability in different populations.

It thus seems reasonable to use the LASSI-II to assess the learning and study strategies of Egyptian undergraduates. In Egypt universities have centers for Education Quality Assurance (EQA) that help faculty members, as well as students, achieve better learning outcomes by offering various educational services.

These services include training workshops on learning strategies, measurement and assessment practices, and educational interventions.

Providing these centers with an adapted Arabic version of the LASSI-II would be a valuable tool to measure learning strategies. The significance of providing such centers with an adapted Arabic version of the LASSI-II is evident in its many uses as discussed earlier. However, the LASSI-II cannot be used within the new Egyptian population without investigating its factor structure and reliability. Accordingly, it is important to estimate the factor structure and score reliability of the LASSI-II among Egyptian undergraduates.

Validity and Score Reliability

Validity is an important property for a psychometrically sound instrument. Investigating the factor structure of educational and psychological instruments is an essential part of examining validity evidence. Construct validity refers to the capacity of the individual indicators proposed to load on the theoretical constructs that they are intended to represent (Rubin & Babbie, 2008). Factorial validity, as used interchangeably with construct validity, is very important when identifying the factor structure of an instrument. Said, Badru, and Shalid (2011) indicated that factor analysis is used to explore the factor structure and latent variables underlying a set of variables. Confirmatory factor analysis is used when the test is developed based on a theory. Thus, using confirmatory factor analysis within the scope of the present study is appropriate to estimate the factor structure of the adapted Arabic version of the LASSI-II.

Similarly, scores reliability is a vital psychometric property for instruments used in educational studies. Wilkinson and the APA Task Force on Statistical Inference (1999) asserted, “[A]uthors should provide reliability coefficients of the scores of the data being analyzed even when the focus of their research is not psychometric. Interpreting the size of observed effects requires an assessment of the reliability of the scores” (p. 596). A test is reliable to the extent to which scores based on the test are stable and accurate. In that sense, reliable instruments are trustworthy. Krach and McCreedy (2010) indicated that both test developers and researchers should do their best to construct and validate reliable test instruments.

Concerning score reliability, a question arises regarding the form of reliability that should be used. This concern leads to a brief discussion of the three models of measurement that underlie estimation of scores reliability. Raykov (1997a) summarized these models and their assumptions. First, the parallel model assumes that items must have equal means, variances, and error variances. It is difficult to meet these

assumptions in the real-world data. Thus, this model is the most restrictive in estimating reliability of scores.

Second, the essentially-tau equivalent model assumes the same true score variance for all items, which is difficult to satisfy with real data. However, this model allows the true score means, as well as the error variances, to vary across items, which makes it less restrictive than the parallel model. Third, the congeneric model allows means, variances, and the error variances to vary across items, which makes it the least restrictive model of estimating scores reliability. Thus, the congeneric model gives the most accurate estimates of reliability among the three models simply because of its flexible assumptions.

Graham (2006) noted that alpha depends on the essentially-tau equivalent model of measurement that also assumes all items load on the same common factor with equal loadings. This assumption is also difficult to meet in the real-world data. Alpha therefore underestimates the reliability coefficient because of the probable violations of the essentially-tau equivalent model.

On the other hand, omega coefficient, introduced by Heise and Bohrnstedt in 1970, complies with the congeneric model of measurement that assumes all items load on the same common factor but allows for different loadings. Accordingly, many researchers have recently recommended using some alternatives to alpha such as omega as the latter gives more robust estimates (Cronbach & Shavelson, 2004; Dunn, Baguley, & Brunson, 2014; Green, & Yang, 2009; Raykov, 1997a; Raykov, 1997b; Revelle, & Zinbarg, 2009). To date, no study was observed reported omega coefficients for estimating the score reliability of the LASSI-II. In that sense, estimating the score reliability of an adapted Arabic version of the LASSI-II using omega coefficients provides more precise and accurate estimates.

Factor Structure and Score Reliability of the LASSI-I

As attempts to validate the LASSI within different populations, a large body of research examined the factor structure of the LASSI-I and LASSI-HS. For instance, Murphy and Alexander (1998) investigated the factor structure of the LASSI-HS among 139 ninth grade Singaporean females. The results of exploratory factor structure failed to confirm the 10 subscales proposed in the user's manual. Similarly, Melancon (2002) used a sample of 502 undergraduates in New Orleans and found that the items do not necessarily measure the ten subscales proposed in the user's manual. Based on the results of exploratory factor analysis, he reported that fewer than 10 constructs were measured by the LASSI-I. However, Yip (2013) used exploratory factor analysis and indicated that the items

of the LASSI-I loaded on their hypothesized constructs as stated in the user's manual.

Thompson and Daniel (1996) indicated that researchers should examine different plausible models to find the one that best fits their data. Hence, some researchers conducted studies on the factor structure of the subscales of the LASSI and reached different models. Opposed to the original model proposed by the test authors, some researchers obtained other models for the LASSI-I and LASSI-HS. For instance, Olivarez and Tallent-Runnels (1994) examined the factor structure of the LASSI-HS among 367 students. The results of exploratory factor analysis indicated that the proposed model explained 68% of the total variance. The first factor consisted of the first five subscales: test strategies, anxiety, selecting main ideas, concentration, and attitude. The second factor consisted of the last five subscales: study aids, self-testing, information processing, motivation, and time management.

Olaussen and Braten (1998) used a sample of 173 first-year and 176 second-year Norwegian college, and the results of confirmatory factor analysis revealed a three-factor model. Based on the refinement of the model proposed by Olejnik and Nist (1992), Olaussen and Braten (1998) labeled them effort-related activities (motivation, time management, concentration, attitude, and test strategies), goal orientation (concentration, attitude, test strategies, anxiety, selecting main ideas, and information processing), and cognitive activities (selecting main ideas, information processing, study aids, and self-testing). Later, this model became known as the ER-GO-CA model of learning and study strategies.

In an attempt to confirm the ER-GO-CA model, Samuelstuen (2003) also investigated the underlying factor structure of the LASSI-HS subscales in Norwegian students. He used confirmatory factor analysis and identified the same model reported by Olaussen and Braten (1998) but with different subscales on the second latent factor: goal orientation (test strategies, anxiety, attitude, concentration, and selecting main ideas). Stevens and Tallent-Runnels (2004) used confirmatory factor analysis to identify the latent factors underlying the LASSI-HS subscales. They obtained the same model identified by Olaussen and Braten (1998).

On the other hand, some researchers investigated the factor structure of the LASSI-I and LASSI-HS and labelled the components differently. Murphy and Alexander (1998) used confirmatory factor analysis, identified a three-factor model, and labeled them affective/effort-related activities (time management, concentration, attitude, and motivation), cognitive activities (information processing, study aids, and self-testing), and anxiety/arousing activities (anxiety, selecting main ideas, and test strategies). Cano (2006) investigated the latent structure of the LASSI-I subscales

among undergraduates. He used confirmatory factor analysis, obtained a three-factor model, and labeled them affective strategies (motivation, time management, concentration, attitude, and self-testing), goal strategies (concentration, attitude, anxiety, test strategies, and selecting main ideas), and comprehension monitoring strategies (selecting main ideas, information processing, study aids, and self-testing).

Concerning the score reliability estimates of the LASSI-I reported in previous literature, Weinstein and Palmer (1987) found that alpha coefficients for the subscales ranged from a low of .68 (study aids) to a high of .86 (time management). In 1990, they concluded that alpha coefficients ranged from a low of .68 (study aids) to a high of .82 (anxiety and concentration) for the LASSI-HS. Olaussen and Braten (1998) reported alpha coefficients to range from a low of .68 (study aids) to a high of .84 (concentration). Melancon (2002) found alpha coefficients ranged from a low of .66 (study aids) to a high of .85 (concentration). Cano (2006) reported alpha coefficients from a low of .61 (attitude) to a high of .84 (time management). Study aids was found to have the lowest alpha coefficient in most of the studies reported above, whereas concentration and time management were found to have the highest alpha coefficient respectively.

Factor Structure and Scores Reliability of the LASSI-II

Compared to the LASSI-I, few studies have investigated the psychometric properties of the LASSI-II because it is a relatively recent version. Weinstein and Palmer (2002) did not use factor analysis to confirm the factor structure of the proposed constructs. They depended essentially on the views of experts concerning the relevance of items to their constructs, as well as the relevance of the subscales to the S-W-SR model. They also investigated the inter-scale correlations and found them to be significant, ranging from a low of .07 (anxiety \times study aids) to a high of .67 (concentration \times time management).

Flowers (2003) emphasized that additional validity evidence is needed on the factor structure of LASSI-II. Accordingly, Cubukcu (2007) indicated that, after the removal of a few items of the LASSI-II for psychometric reasons, the remaining items formed eight subscales (motivation, attitude, time management, concentration skills, test strategies, selecting main ideas, information processing, and study aids). Other researchers examined other forms of validity evidence for the LASSI-II. For instance, Mancuso (2008) examined the predictive validity of the LASSI-II among undergraduates, specifically assessing the LASSI's

capacity to predict college success and retention. Results indicated that the LASSI-II was a significant predictor of college success.

Flowers, Bridges, and Moore (2012) examined the concurrent validity of the LASSI-II among African-American pre-collegiate students. Data analysis revealed that two of the 10 LASSI-II subscales (i.e., anxiety and test strategies) significantly correlated with a measure of academic ability. Finch, Cassady, and Jones (2016) recommended conducting other validity studies on the item level of the LASSI-II within new populations. This strengthens the need to conduct the present study within the Egyptian population.

Regarding the validation of the LASSI-II subscales, Prevatt, Petscher, Proctor, Hurst, and Adams (2006) compared both the ER-GO-CA model and the S-W-SR model among 297 college students. Based on the results of confirmatory factor analysis, their data supported the ER-GO-CA model. However, Yip (2013) examined the underlying factor structure subscales in 612 university students from Hong Kong. Using confirmatory factor analysis, the results revealed that the best-fitting model was a three-factor model similar to the S-W-SR model proposed by the test authors (Weinstein & Palmer, 2002). Thus, it seems obvious that the two competing models were (1) the original S-W-SR model proposed by the test authors, Weinstein and Palmer (2002), and (2) the ER-GO-CA model proposed by Olejnik and Nist (1992) and refined by Olaussen and Braten (1998).

As for the score reliability estimates of the LASSI-II reported in previous research, Weinstein and Palmer (2002) found that alpha coefficients for the subscales ranged from a low of .73 (study aids) to a high of .89 (selecting main ideas). Flowers (2003) emphasized that other research should be conducted to investigate the scores reliability of the subscales, especially on the second edition. He added that less research has been done on the second edition compared to the first edition.

Accordingly, numerous researchers conducted several studies and examined the reliability and use of the LASSI-II to assess learning strategies of students in different populations. For instance, Prevatt et al. (2006) investigated the reliability of the LASSI-II and found that alpha coefficients ranged from a low of .66 (study aids) to a high of .91 (concentration). Cubukcu (2007) reported that alpha coefficients ranged from .73 to .85 among Turkish students. Yip (2007) reported that alpha coefficient ranged from .60 (attitude) to .81 (motivation) for Chinese students. Iqbal, Sohal, and Shahzad (2010) also reported that alpha coefficients ranged from a low of .68 to a high of .82 for Pakistani students. Study aids was also found to have the lowest alpha coefficient in most of the studies reported above.

The Present Study

Based on the previous review, there has been less research done on the factor structure of the LASSI-II compared to the LASSI-I. In more details, many of the studies reported thus far were conducted using the LASSI-I (Cano, 2006; Melancon, 2002; Olaussen & Braten, 1998; Weinstein & Palmer, 1987; Yip, 2013). Others were conducted using the LASSI-HS within different populations (Murphy & Alexander, 1998; Olivarez & Tallent-Runnels, 1994; Samuelstuen, 2003; Stevens & Tallent-Runnels, 2004). Some studies also investigated the underlying factor structure, other types of validity, and reliability of the LASSI-II within different populations (Cubukcu, 2007; Flowers et al., 2012; Mancuso, 2008; Prevatt et al., 2006). However, very little attention has been paid by researchers concerning the psychometrics properties of the LASSI-II in the Arab countries.

A review of literature published in Egypt revealed a paucity of research investigating Egyptian undergraduate learning and study strategies. Only two correlational studies were identified: one by Ahmed (2010) and the other by Rashed and Eltayeb (2009). They did not conduct factor analysis of the translated LASSI-II adopted in their studies that consequently limits the use and applicability of their results. Thus far, there has been no published investigation of the factor structure of the items, the underlying factor structure for the subscales, and the congeneric reliability (omega coefficient) of an adapted Arabic version of the LASSI-II among Egyptian undergraduates. Accordingly, it is appropriate to investigate the factor structure of the Arabic version of the LASSI-II using confirmatory factor analysis.

The present study tries to fill the gap identified through the review of literature by addressing the following questions: (1) Does the Arabic version of the LASSI-II items fit their proposed theoretical constructs (subscales)?, (2) What is the underlying factor structure of the Arabic version of the LASSI-II subscales based on comparing the two competing models of learning and study strategies?, and (3) Are the omega reliability coefficients of the Arabic version of the LASSI-II subscales large enough to indicate that the subscales have acceptable levels of score reliability?

In this study, such questions are addressed. In other words, addressing these issues contributes to the educational and psychological literature of measuring learning and study strategies especially in the Arab community by presenting a validated version of the LASSI-II. Additionally, using the congeneric model of measurement (omega coefficients) to estimate score reliability is regarded a unique contribution of the present study.

Method

Participants

All participants were third-year undergraduate students enrolled at South Valley University, Egypt. Participants were 303 students (108 males [35.64%], 195 females [64.36%], $M_{age} = 20.15$ years; age range: 19-22 years). One hundred and fifty-one (51.16%) of the participants were from literary colleges (Education and Arts), whereas 148 (48.84%) of the participants were from scientific colleges (Veterinary Medicine, Engineering, and Science). They participated in the study voluntarily. All participants completed an adapted Arabic version of the LASSI-II.

Instruments

An adapted Arabic version of the LASSI-II was used in the present study. It assesses 10 subscales of learning and study strategies: information processing, selecting main ideas, test strategies, anxiety, attitude, motivation, concentration, self-testing, study aids, and time management. The inventory has 80 items, eight for each subscale. Each item is a statement that participants rate on a 5-point Likert scale ranging from "totally applicable for me" to "totally inapplicable for me". There is no total score of the LASSI-II because it is a diagnostic instrument.

Procedures

Before data collection, the LASSI-II was translated into Arabic utilizing the back-translation technique (Brislin, 1970). Translating the LASSI-II went through many steps. Firstly, two bilingual professors and I translated the inventory into Arabic. Secondly, the preliminary translated version and the original version were handed to two other bilingual educational psychology professors to review each item and ascertain the accuracy of translation and comparability of meaning. They made few changes, and corrections were carried out accordingly. Thirdly, another bilingual educational psychology professor translated it back into English. Finally, the original version was compared with the back-translated version, and similarity was found between them. This indicated the accuracy of the Arabic translated version and its appropriateness to measure the same learning and study strategies measured by the original LASSI-II.

Then educational authorities were contacted to seek permission to administer the instrument. Teaching assistants distributed the instrument to the students in their various classes in the spring of 2013 and explained briefly but clearly the purpose of the study and how to complete the instrument. Finally, responses were collected and scored.

Table 1
Goodness-of-Fit Indices for the Factor Structures of the LASSI-II Items (N=303)

Subscale	<i>df</i>	χ^2	χ^2/df	GFI	AGFI	RMSEA
INP	20	72.80***	3.64	.93	.89	.080
SMI	14	19.21	1.37	.98	.96	.035
TST	20	27.81	1.39	.98	.96	.036
ANX	20	86.74***	4.33	.93	.87	.070
ATT	14	42.80***	3.05	.96	.92	.073
MOT	20	57.55***	2.88	.95	.91	.079
CON	20	58.25***	2.91	.95	.91	.079
SFT	20	76.25***	3.81	.90	.82	.080
STA	20	89.87***	4.49	.92	.86	.078
TMT	20	77.83***	3.89	.93	.88	.077

Note. INP = information processing; SMI = selecting main ideas; TST = test strategies; ANX = anxiety; ATT = attitude; MOT = motivation; CON = concentration; SFT = self-testing; STA = study aids; TMT = time management. χ^2 = chi-square statistics; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMSEA = root mean square error approximation.

*** $P < .001$

Results

Before conducting data analysis, data screening was conducted for accuracy purposes. Confirmatory factor analysis was utilized for investigating the factor structure of items and subscales of the LASSI-II. The objective was to confirm or reject the proposed models. The results were presented based on the sequence of the research questions as follows:

The Factor Structure of the LASSI-II on the Item Level

To examine whether the LASSI-II items load on their proposed subscales, confirmatory factor analysis was conducted using jMetrik software (version 2), a user-friendly computer software for item analysis (Meyer, 2011). In the present study, model fit for each subscale was evaluated using χ^2 statistics, χ^2/df , goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and root mean square error of approximation (RMSEA). Thompson and Daniel (1996) stated that reliance on chi-square and degrees of freedom to test model fit is problematic as it is sensitive to large sample sizes that lead to inflated values. However, these values should still be reported. Accordingly, χ^2/df should be computed and reported to adjust for sample size.

The standard fit indices accepted in related previous research were χ^2/df (0-5), GFI $\geq .90$, and AGFI $\geq .80$. RMSEA values $\leq .06$ indicate a close fit, and values up to .08 are acceptable (Brown, 2006; Hu & Bentler, 1999; Steiger, 1990). Hoe (2008) reported, "RMSEA run on a continuum from 0 to 1. Values less than .05 indicate good fit, values up to .08 indicate reasonable fit, and ones up to .10 indicate mediocre fit" (p. 78).

Based on the confirmatory factor analysis results, two items were deleted because of their small loadings on their hypothesized subscales. Their deletion resulted in improving the fit indices as well as reliability coefficients. The first item belonged to the selecting main idea subscale and had a loading of .16. This item asked about "taking notes in the class." The second item belonged to the attitude subscale that had a loading of -.19. This item asked if "the time of finishing study does not matter if a student has enough time,"

Table 1 shows the goodness-of-fit indices for the 10 subscales. Based on the heretofore-mentioned fit indices, eight subscales had good fit indices: namely, information processing, anxiety, motivation, concentration, self-testing, study aids, and time management.

The selecting main ideas subscale had the best fit indices among the 10 subscales. The fit index values were $\chi^2/df = 1.37$; GFI = .98; AGFI = .96; and RMSEA = .035. On the other hand, the self-testing subscale had the least reasonable fit indices among the 10 subscales. The fit index values were $\chi^2/df = 3.81$; GFI = .90; AGFI = .82; and RMSEA = .080. However, these values were within the acceptable range. In summary, the factor structure of the 10 LASSI-II subscales had satisfactory fit indices among Egyptian undergraduates. Accordingly, the adapted Arabic version of the LASSI-II can very likely be used for measuring learning strategies and for research purposes in Arab-speaking countries.

The Underlying Factor Structure of the 10 LASSI-II Subscales

To identify the underlying factor structure of the Arabic version of the LASSI-II subscales, the original S-W-SR model was compared to the ER-GO-CA

Table 2

Goodness-of-Fit Indices of the Underlying Factor Structure of the Two Competing Models for the LASSI-II Subscales (N = 303)

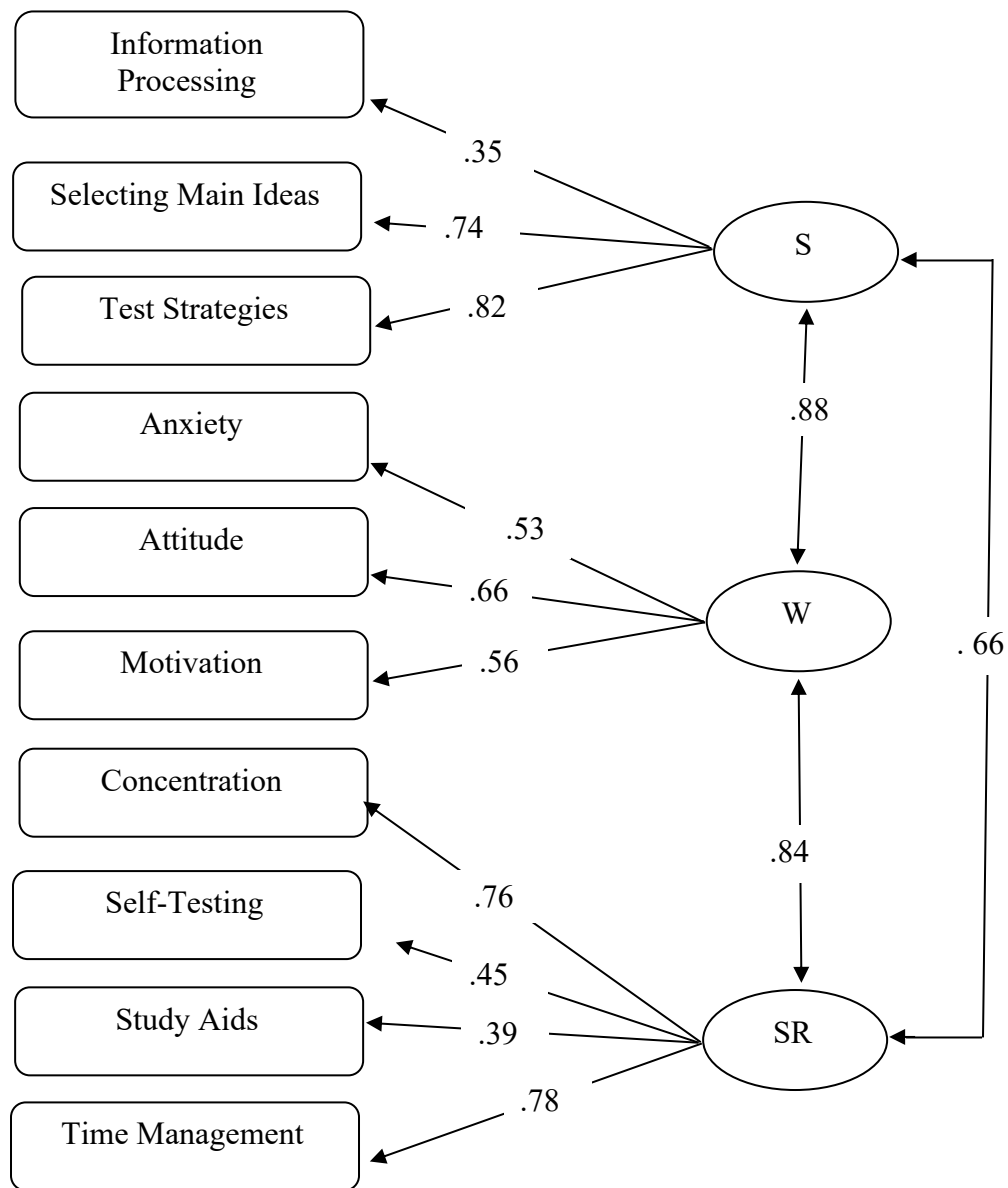
Model	df	χ^2	χ^2/df	GFI	AGFI	CFI	RFI	RMSEA	90 % CI
S-W-SR	32	402.22****	12.57	.79	.64	.83	.74	.196	(.18-.21)
ER-GO-CA	30	120.77****	4.03	.93	.86	.95	.90	.079	(.072-.086)

Note. S-W-SR = skill-will-self-regulation; ER-Go-CA = effort related-goal orientation-cognitive activities. χ^2 = chi-square statistics; GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; CFI = comparative fit index; RFI = relative fit index; RMSEA = root mean square error approximation; CI = confidence intervals.

**** $P < .0001$

Figure 1

Standardized maximum likelihood estimates of correlation coefficients for model (S-W-SR) model of the LASSI-II. S = skill; W = will; SR = self-regulation.



model. Two confirmatory factor analyses (CFAs) were conducted with maximum likelihood (ML) using LISREL 8.80 for Windows (Jöreskog & Sörbom, 2006). In the present study, the fit indices for the two competing models were evaluated using the previous criteria. Two new indices were added—the comparative fit index (CFI) and the relative fit index (RFI)—as they help compare the best fit of the two competing models. Both CFI and RFI should be $\geq .90$ for an acceptable fit. Additionally, RMSEA Confidence Intervals (CI) for RMSEA were added.

Table 2 shows the results of the two competing models. According to these results, the ER-GO-CA model had better fit than the S-W-SR model based on the accepted criteria discussed earlier. This implies that the ER-GO-CA model is consistent with the population covariance matrix. In other words, this also indicates little difference between the observed and reproduced covariance matrices.

Figure 1 shows the standardized maximum likelihood estimates of the correlation coefficients among the three latent factors and the subscales of the S-W-SR model. Based on the results, the ER-GO-CA model was adopted as it best fits the Egyptian data. The latent factors were labeled the same as those by Olaussen and Braten (1998).

Figure 2 shows the standardized maximum likelihood estimates of the correlation coefficients among the three latent factors and the subscales. The first latent factor (effort-related activities) captured motivation, time management, concentration, and the revised attitude subscales. This factor was strongly correlated to the time management subscale, $r = .77$. The second latent factor (goal orientation) captured concentration, attitude, test strategies, anxiety, and the revised selecting main ideas subscales. This factor was strongly correlated to the test strategies subscale, $r = .82$. The third latent factor (cognitive activities) captures information processing, self-testing, and study aids subscales. This factor was strongly correlated to the self-testing subscale, $r = .79$. The correlation coefficient between the effort-related activities factor and the cognitive activities factor was .62. In addition, the correlation coefficient between the effort-related activities factor and the goal orientation factor was .60. The correlation coefficient between the goal orientation factor, and the cognitive activities factor was .23.

Congeneric Reliability (Omega Coefficients)

To estimate the omega reliability coefficients of the LASSI-II subscales and compare them to alpha coefficients, confirmatory factor analysis was also conducted. Table 3 shows the means, standard deviations, the congeneric reliability estimates (omega

coefficients), and alpha coefficients for the LASSI-II subscales. Omega values for the subscales ranged from a low of .65 (Study Aids) to a high of .86 (Self-testing). On the other hand, alpha values ranged from a low of .63 (Study Aids) to a high of .82 (Self-testing).

These results confirmed the study hypothesis that alpha underestimates reliability. Thus, omega is preferred. Some subscales had better omega coefficients after the deletion of some items as discussed earlier. For instance, Ω was found to be .78 for selecting main ideas, and $\Omega = .67$ for attitude. Generally speaking, omega reliability coefficients of the LASSI-II subscales are satisfactory for use within the Egyptian population.

Discussion

This study examined the test factor structure on the item level, the underlying factor structure of the subscales, and the congeneric reliability (omega coefficient) of an adapted Arabic version of the LASSI-II among Egyptian undergraduates. The first purpose of the study was to investigate the factor structure of the LASSI-II on the item level as recommended by recent publications. Initially, the instrument developers did not examine the factor structure of the items.

The results of this study were consistent with the results reported by Yip (2013) that the inventory measures the 10 subscales reported in the user's manual. However, the results of the study were not consistent with the results of other studies (Cubukcu, 2007; Melancon, 2002; Murphy & Alexander, 1998), which indicated that fewer than 10 subscales may be measured by the inventory.

The second purpose of the study was to investigate the latent factor structure among the 10 subscales of the LASSI-II. Two competing models were examined using CFA. The results revealed that data fits well the ER-GO-CA model proposed by Olejnik and Nist (1992) and refined by Olaussen and Braten (1998). The results of the present study were consistent with the results reported by other researchers (Cano, 2006; Olaussen, & Braten, 1998; Prevatt et al, 2006; Samuelstuen, 2003). On the other hand, the results of the present study were not consistent with the results reported in other studies (Weinstein, & Palmer, 2002; Yip, 2013).

That a different model was confirmed from that proposed by the test authors may be explained by the fact that the test authors developed the test based upon expert opinions that might not be consistent with the results from statistical techniques such as the confirmatory analyses. In other words, the ER-GO-CA model seems to have a theoretical and empirical framework that has increased its goodness-of-fit to the data collected in the present study. To conclude, the S-

Table 3

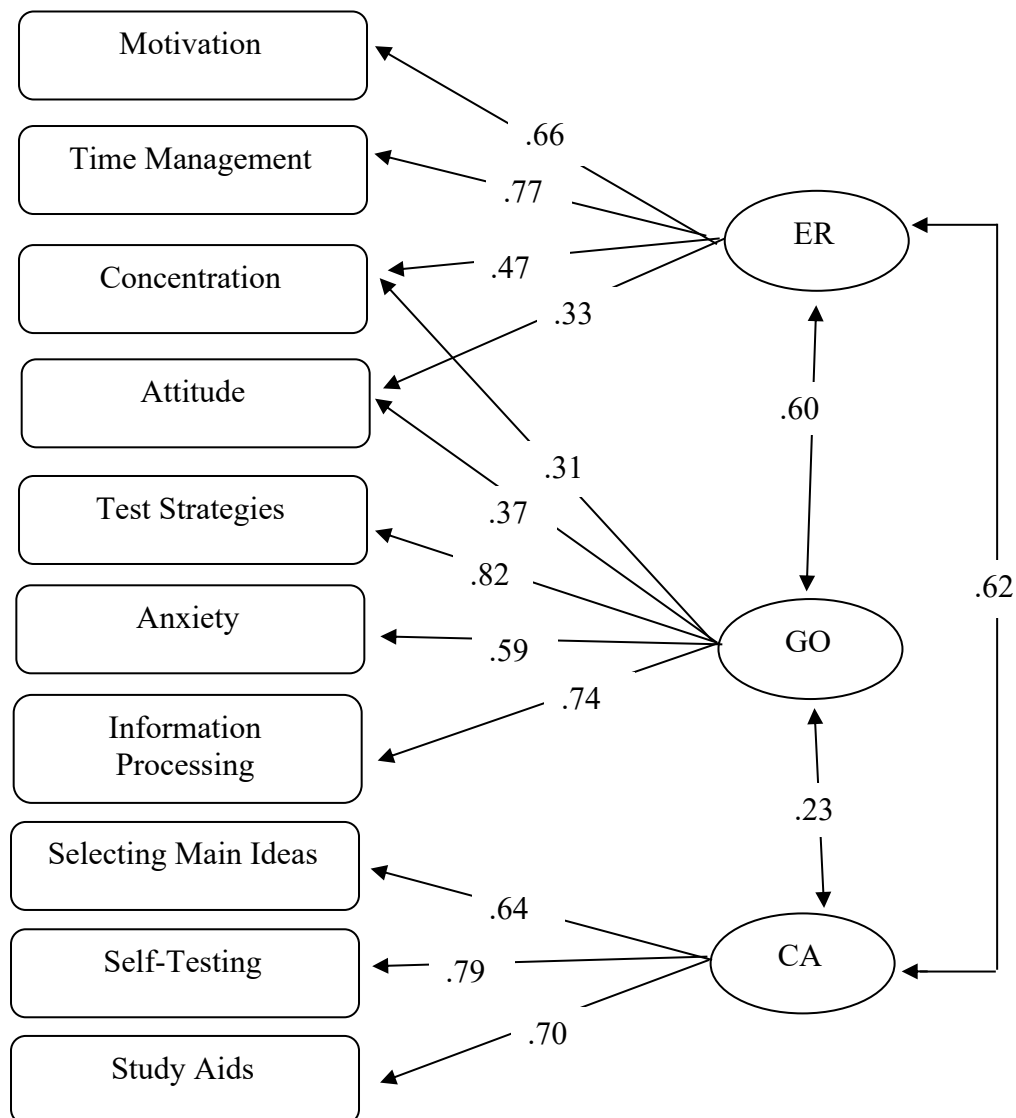
Means, Standard Deviations, and Reliability Coefficients (Omega/Alpha) for the LASSI-II Subscales (N=303)

Subscale	INP	SMI	TST	ANX	ATT	MOT	CON	SFT	STA	TMT
<i>M</i>	28.84	20.99	24.95	18.24	24.64	30.32	21.93	26.67	27.72	23.15
<i>SD</i>	4.71	5.09	5.63	6.04	5.05	5.41	5.22	5.97	4.81	5.28
Omega	.73	.78	.71	.80	.67	.77	.79	.86	.65	.76
Alpha	.71	.71	.70	.77	.65	.76	.67	.82	.63	.67

Note. INP = information processing; SMI = selecting main ideas; TST = test strategies; ANX = anxiety; ATT = attitude; MOT = motivation; CON = concentration; SFT = self-testing; STA = study aids; TMT = time management. Alpha values were provided to illustrate how alpha underestimates scores reliability coefficients and not as an objective of the present study.
 * $P < .05$, ** $P < .01$

Figure 2

Standardized maximum likelihood estimates of correlation coefficients for (ER-GO-CA) model of the LASSI-II. ER = effort-related activities; GO = goal orientation; CA = cognitive activities.



W-SR model is theoretical, whereas the ER-GO-CA model is empirical and data-based. It was confirmed by many empirical studies as discussed in the review of the literature.

The effort-related activities factor captured the subscales that required effort, persistence, and desire to work hard, such as motivation and time management. The goal orientation factor captured the subscale that required students to set their goals, such as selecting main ideas. It also captured the subscales that were related to affective strategies, such as anxiety, and test strategies. The cognitive activities factor captured the subscales that required some cognitive abilities such as information processing and self-testing. To sum up, there was empirical evidence for the ER-GO-CA model compared to the S-W-SR model. Accordingly, the ER-GO-CA model should be used.

The LASSI-II is multidimensional, and some of the subscales were captured by more than one latent variable, which means that these latent constructs are more complex than what was proposed by the inventory authors. It should also be noted that there is a strong relationship between the effort-related activities factor and the cognitive activities factor. This may be due to the nature of the subscales in both components that require motivation to use study aids and concentration to process information effectively, etc. On the other hand, there is a weak relationship between the goal orientation factor and the cognitive activities factor. This may be due to the fact that anxiety as one of the subscales of the goal orientation component may be negatively correlated to information processing, self-testing, and study aids as subscales comprising the cognitive activities component.

The third purpose of the study was to estimate the congeneric reliability of the LASSI-II. Omega coefficients ranged from a low of .65 (Study Aids) to a high of .86 (Self-testing). On the other hand, alpha coefficients ranged from a low of .63 (Study Aids) to a high of .82 (Self-testing). Some of these coefficients were comparable, and others (attitude and study aids) were lower than those reported in the LASSI-II user's manual (Weinstein & Palmer, 2002).

Given the fact that reliability is a property of the scores and not an absolute property of the test, student attitudes and student use of study aids may differ from one society to another. This difference may affect student responses and consequently lower score reliability coefficients. Accordingly, attitude and study aids subscales are reliable given the fact that there is psychometric literature that documented that a reliability coefficient greater than or equal to .65 is considered acceptable.

In addition, these results were in agreement with the results of some researchers such as Prevatt et al. (2006), who indicated that the study aids subscale

had the lowest reliability coefficient among all subscales. In general, there was consistency between the results of the present study and previous research that reported similar coefficients to those mentioned in the user's manual (Iqbal et al., 2010; Yip, 2007; Yip, 2013). Using congeneric reliability was considered an advantage of this study as compared to all related previous studies that used the alpha coefficient for estimating scores reliability. In general, the LASSI-II subscales were consistent and stable for Egyptian undergraduates.

Limitations and Directions for Future Research

There were some limitations to the present study. First, it only addressed two aspects of score reliability, i.e., alpha and omega; other research may utilize generalizability theory. Second, it only covered one form of validity evidence, construct validity. Thus, future research may investigate concurrent or predictive forms of validity of the LASSI-II within the Arab community.

Another limitation is that students participating in the present study were all attending the same university. Cultural differences may exist between students in Egypt and other countries in the Arab world. These differences may affect student responses on the LASSI-II. Thus, subsequent research may examine the psychometric properties of the LASSI-II among other populations in the Arab countries.

In other words, the original 10-factor model for LASSI-II (Weinstein & Palmer, 2002) needs to be cross-validated with different samples and within different populations. Based on the adapted and psychometrically validated Arabic version of the LASSI-II, comparing and contrasting the profiles of learning and study strategies of different populations of students may be another useful direction for future research. Other studies may use the different IRT models to further investigate the psychometric properties of the LASSI-II.

Conclusion

In conclusion, this adapted Arabic version of the LASSI-II will provide students, educators, faculty members, and stakeholders with a psychometrically validated instrument for measuring learning and study strategies in Egypt in particular and in the Arab world in general. The validated instrument may also be used in different projects to assess the learning and strategies utilized by college students in different academic settings. Assessing the learning and study strategies of Egyptian undergraduates using a validated instrument will also help in identifying

student deficits and in planning intervention programs to promote success in college.

Additionally, assessing student learning and study strategies is central to improving the intended learning outcomes. Finally, alongside with research in western countries, researchers from the Arab world may use the new validated instrument in conducting correlational research to investigate the relationship between learning and study strategies and other educational variables such as self-efficacy, personality traits, thinking styles, and so on.

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